



A Review of formwork systems for modern concrete construction

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Abstract -

Concrete is the main building material in the construction industry. Formwork plays an important role in the formation and development of the strength of concrete elements. It is also one of the main cost items in the construction of a concrete structure. The use of formwork has a long history and various formwork systems have been used in different projects. Requirements such as safety, cost, structural geometry, construction time and surface quality must be considered when designing and selecting formwork systems. This white paper provides a comprehensive overview of the various formwork systems in concrete structures, including raw materials, flexibility, production methods, concrete application and environmental impact. After comparing and discussing the current advantages and limitations of various formwork systems, we finally make a recommendation.

Key Words: Formwork; concrete structure; concrete construction; traditional formwork

1. Introduction

Concrete is the main building material in the construction industry. It is widely used in residential and commercial buildings and infrastructure due to its superior design properties such as structural properties, reliability, economy and low cost, as well as its flexibility to achieve any shape regardless of geometry and complexity. Formwork is very important in the construction of concrete structures. On the one hand, concrete can be given any shape. On the other hand, fresh concrete may gradually gain strength to support the structure.

The use of formwork dates back to the Roman Empire [1]. At that time, wooden formwork was used by Roman engineers as formwork for the construction of reinforced concrete vaults and arches [2]. During the Renaissance, formwork was increasingly used in the construction of concrete structures. Compared to masonry buildings, concrete buildings require significantly less construction work, and the use of formwork is advantageous in the construction of conventional concrete structures. In the 20th century, various types of formwork were developed, which became an integral part of the construction of reinforced concrete structures. According to material hardness, recyclability and production process, formwork systems can be divided into traditional formwork systems, flexible formwork systems and recyclable formwork systems, as shown in the figure. 1 Traditional formwork, made of hard materials and commonly used for regular geometry structures, has been used in concrete construction since ancient times. Wooden formwork and metal formwork are the two most commonly used forms of traditional formwork [3]. Due to the growing demand for static efficiency and aesthetics, in recent decades, flexible formwork systems have been developed that are used in the construction of geometrically complex concrete elements and structures. Fabric formwork systems and digitally manufactured formwork systems are the two main forms of flexible formwork systems [4-6]. As the construction industry is a major contributor to greenhouse gas emissions and climate change has attracted worldwide attention in recent years [7], the use of recyclable and environmentally friendly materials such as sand and ice as formwork has gained acceptance in recent years. brought in. year. year. It has proven itself in the production of individual concrete components [8].

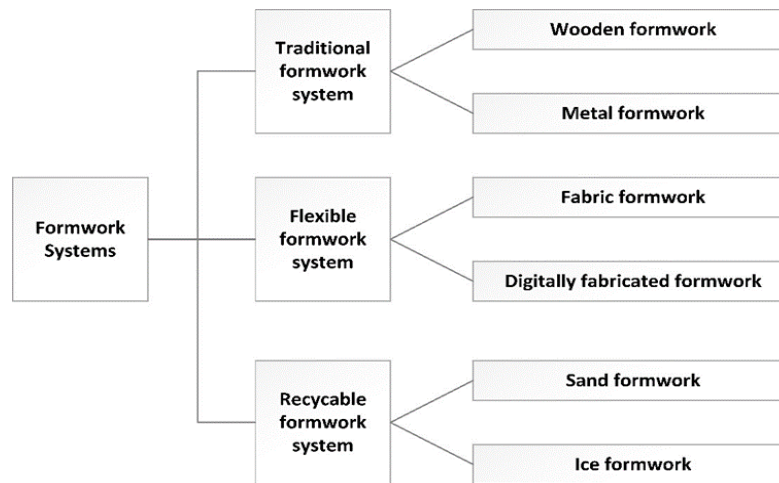


Fig. 1 Classification of formwork systems.

2. General requirements in formwork design

Formwork is a temporary support for the construction of concrete structures and is primarily used to form and support fresh concrete until it reaches the required strength. The final shape and surface quality of a finished concrete structure is highly dependent on the formwork system used in the structure [9]. Therefore, the selection criteria and the basic requirements for the formwork system should be carefully studied before starting construction [10, 11]. First of all, the formwork system must have excellent quality in terms of strength, durability and rigidity and ensure the safety of the construction process [12, 13]. This requires a careful analysis of possible loads, especially lateral stresses in the formwork. You then need to select the appropriate formwork material and scaffolding system that is strong enough to withstand the load

Price, including the cost of materials, is also an important factor when choosing a formwork system. labor costs for formwork, installation and dismantling, cost of formwork equipment; The cost of insulation during the dismantling of the formwork [14]. The cost of the formwork system can be up to half of the total cost of building a monolithic concrete structure [15]. Therefore, material savings and the possibility of reusing formwork are very important when choosing and designing a formwork system. In addition, weather-sensitive formwork materials increase maintenance costs and shorten service life. In general, it is recommended to use materials with sufficient resistance to severe damage and corrosion. For example, in areas where it constantly rains, plywood formwork is considered to be more preferable than steel formwork because steel corrosion not only shortens the life of the formwork system, but also damages the concrete surface.

The ergonomics and flexibility of the formwork are also determining factors in the design of the formwork system [16]. Ergonomic formwork means easy and efficient assembly of formwork elements and pouring new concrete. Due to the versatility of formwork, concrete components can be formed from a single formwork system in a variety of geometries and locations. For example, fabric formwork can be made from a single fabric panel, which is a relatively time-saving method. At the same time, the flexibility of the fabric formwork allows the formation of non-standard shapes.

3. Traditional formwork system

Traditional formworks are usually fabricated with rigid materials such as wood and metal for the construction of concrete structures with regular geometries. These formworks are usually constructed manually by skilled craftsmen. As the application of traditional formworks has a long history, the techniques involved in fabrication such as cutting, assembling and erecting of formwork members have been well established. In this section, a detailed review of the characteristics and applications of wooden formwork, steel formwork and aluminium formwork will be presented.

Plastic formwork

Plastic formwork for the construction of walls, pillars, plinths, and round, oval, and square columns



GEOPANEL



GEOPANEL STAR



GEOTUBE



GEOTUBE PANEL

PLASTIC FORMWORK PRODUCTS: TRAITS AND BENEFITS

Geoplast plastic formwork is suitable for on-site erection of concrete columns, columns, walls, foundations and foundations. Our formwork products are modular to meet a variety of building and planning needs, including columns and piers of various shapes and sizes, walls and foundations of various thicknesses and heights. Our Geopanel, Geopanel Star, Geotub and Geotub formwork products are very light compared to conventional wood panels. It is also made of plastic to prevent concrete from sticking. All elements can be easily cleaned with a little water and reused. With proper care, Geoplast formwork products can be reused more than 100 times. It can be rented out, minimizing the initial investment and providing significant material and storage space savings. Geopanel is a modular plastic formwork for the construction of concrete walls, foundations and columns of square or oval section. They come in different sizes, so you can easily create designs in different sizes and shapes. It is possible to build walls of any thickness and height. The wall panels are made of ABS plastic, a material that is very light and easy to work with. Geopanel can also be used to construct roofs, stairs and shafts. The panel weighs only 11 kg, so assembly and disassembly is very fast. The reuse process can be quickly repeated across multiple floors of a building. Geopanel is ideal for use inside buildings or on construction sites that are inaccessible to cranes and machinery.

Aluminum Formwork System

A relatively new technology in India, aluminum formwork systems save time and money and improve construction efficiency. Aluminum formwork systems are very economical for repetitive building projects. This is one technology that is considered very suitable for mass construction situations in India that require good quality and speed. This system builds faster than most other deployment methods. Workers use this method effectively to expedite construction while ensuring quality control and durability. All kinds of conditions or building elements such as large windows, stairs, balconies and other architectural elements can be made with aluminum formwork panels [17]. Stones are not needed. It provides a durable finish, requires no exterior or interior plastering, and can be painted immediately with minimal overcoating, resulting in long-term cost savings.



Aluminum formwork system

Tunnel Formwork System

Tunnel formwork Spatial metal formwork is used to create solid monolithic buildings such as side walls and reinforced concrete floors. Thermosetting is a method of accelerating the hardening of concrete in tunnel molds heated by hot air jets [18]. Only a large number of modules of the same type and tall structures such as skyscrapers makes this approach economical. After installation of the fittings, electrical and sanitary equipment and tunnel formwork are installed. After pouring concrete, install a gas heater on the shutter and cover the bare surface of the formwork with a heat-resistant curtain. The formwork is then removed with a tower crane and moved to the next floor or to the side as needed. The shape of the tunnel can be fully utilized in large-scale projects with the same buildings or skyscrapers with the same layout.

Tunnel formwork systems are easy to reuse and clean and provide a high quality surface finish. Engineers can also guarantee the building's dimensional accuracy. Another advantage of this type of formwork system is the repetitive nature of construction work,

which adds the added benefit of minimizing labor on site. The shape of the tunnel allows you to create rooms with a width of 2.4 to 6.6 m. Medium tables are created between tunnels with wider gaps (up to 11 m). Half Tunnel is the most important component of the system. Constructed entirely of steel, including formwork surfaces, the half-tunnel provides the necessary rigidity and lines to produce consistently high quality concrete cladding.



Tunnel formwork system

Table Formwork System

Table top formwork, also known as flying formwork, is a large prefabricated formwork and is often a faulty assembly used to form entire sections of a suspended floor slab. In the new development, the machine needed enough space to move its mass around the perimeter of the building on a daily basis. End railings at the support points must withstand high loads. Its flexibility and ease of installation make it suitable for flat floors, beams and ceilings in building projects with conventional floor plans or long repeats. Residential and commercial buildings are two application examples. In addition to high-quality surface treatment, fast assembly is ensured by the easy transport of assembled parts. It also has negligible waste compared to the traditional formwork methods that have been used in the past. Another important aspect is the time savings when using mass formwork technology, which means cost savings, especially for flat slabs. In addition, due to the developed formwork design and repeated processing, there is practically no waste.



Table Formwork System

4. Conclusions

Over the years, many have changed in the construction industry. Formwork is temporary or permanent mould is created which concrete is dispensed. There are different types of formwork available in India, and among the most common were traditional timber formwork, traditional formwork, aluminum formwork, tunnel formwork and table formwork. Each of these is used depending on the purpose and budget for the project.

Formwork is important for many reasons. In a nutshell, formwork is still important in this day and age as it makes construction quicker and cheaper. It also helps workers get the job done faster and better to achieve the best formwork quality. Moreover, formwork provides efficiency and lesser cost.

Aluminum formwork and tunnel formwork are the two major modern technologies used in India where people are aware of aluminum formwork and have started to use it in many buildings in India. Despite the cost and time, many people choose the traditional method because they think the advanced method is more expensive, but in India the advanced method is used for large

construction projects. The study concluded that the introduction of modern formwork systems would improve quality, safety and efficiency while minimizing construction costs and waste. However, the performance of this modern formwork system on construction sites is not entirely satisfactory due to the lack of experience and lack of skilled workers. Enabling factors such as awareness programs, proper worker training and the establishment of standards and guidelines will encourage the use of modern formwork systems in the Indian construction industry.

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